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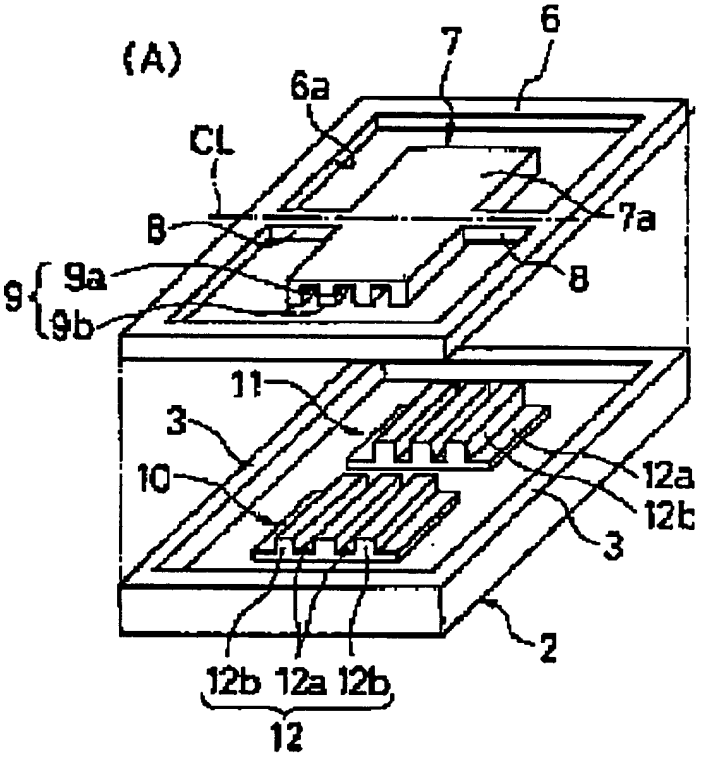
(54) LIGHT DEFLECTOR AND DISPLAY DEVICE USING THE SAME

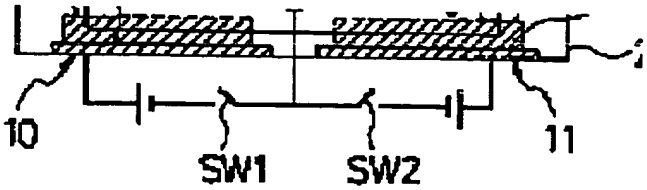
(57) Abstract:

PROBLEM TO BE SOLVED: To obtain a light deflector capable of rocking at high speed and at a wide deflecting angle even under low driving power and also making a reflection mirror part have very high rigidity.

SOLUTION: In this deflector 1, the reflection mirror part 7 is constituted to freely rock on a base 2 through a pair of supporting parts 8 and 8, a pair of fixed electrodes 10 and 11 is arranged on the base 2, and the mirror part 7 is rocked with a pair of supporting parts 8 and 8 as a rocking center axis CL by electrostatic force by applying voltage to space between the electrodes 10 and 11 and the mirror part 7. Then, a mirror side comb-line part 9 consisting of a groove 9a and a projection part 9b extended in a direction orthogonal to the center axis CL is formed on the back surface of the mirror part 7, and an electrode side comb-line part 12 consisting of a groove 12a and a projection part 12b which can be



meshed with the mirror side comb-line part 9 is formed on the mirror part 7 side of the electrodes 10 and 11.



CLAIMS

[Claim(s)]

[Claim 1] The optical deflector characterized by having formed the mirror side ctenidium section characterized by providing the following, and forming the electrode side ctenidium section which changes from the slot and height which can be geared to the aforementioned mirror side ctenidium section at the aforementioned reflective mirror section side of each aforementioned fixed electrode. The reflective mirror section which has a light reflex side on a front face. The supporter of the couple which supports this reflective mirror section free [rocking] to the base. The slot and height which are prolonged in the optical deflector to which it has the fixed electrode of the couple arranged at the reflective mirror section side of the aforementioned base, voltage is impressed between each of this fixed electrode and the aforementioned reflective mirror section, and the aforementioned reflective mirror section rocks the supporter of the aforementioned couple as a center-of-oscillation shaft by electrostatic force in the direction which intersects perpendicularly with the aforementioned center-of-oscillation shaft in the rear face of the aforementioned reflective mirror section.

[Claim 2] The mirror side ctenidium section characterized by providing the following is formed. to the aforementioned reflective mirror section side of each aforementioned fixed electrode The electrode side ctenidium section which changes from the slot and height which can be geared to the aforementioned mirror side ctenidium section is formed. The optical deflector to which voltage is impressed between each aforementioned fixed electrode and the aforementioned reflective mirror section, and the aforementioned reflective mirror section rocks the supporter of the aforementioned couple as a center-of-oscillation shaft by electrostatic force is prepared. Display characterized by irradiating a laser beam at the aforementioned reflective mirror section of this optical deflector, changing the direction of the reflected light of this irradiated laser beam by rocking of the aforementioned reflective mirror section, and acquiring a projection picture. The reflective mirror section which has a light reflex side on a front face. The supporter of the couple which supports this reflective mirror section free [rocking] to the base. The slot and height which are prolonged in the direction which has the fixed electrode of the couple arranged at the reflective mirror section side of the aforementioned base, and intersects perpendicularly with the aforementioned center-of-oscillation shaft in the rear face of the aforementioned reflective mirror section.

[Claim 3] It is the display characterized by projecting the optical information which wrote in by irradiating the reflected light from the aforementioned reflective mirror section in display given in the aforementioned claim 2 at an optical address type space optical modulator, and was written in this optical address type space optical modulator.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the optical deflector which is made to reflect light, such as a laser beam, and performs an optical deflection, and the display using this optical deflector.
[0002]
[Description of the Prior Art] The optical polariscope is used for the optical-deflection equipment of the scanner of optical instruments, such as an electrophotography formula copying machine, a laser beam printer, and a bar code reader, and the tracking-control equipment of an optical disk, and the display which scans a laser beam and projects an image.
[0003] As an optical polariscope which generally performs an optical deflection mechanically, although there are a rotating polygon (polygon mirror), a stirred-up type reflecting mirror (galvanomirror) of a riot, etc., a mechanism can be miniaturized compared with a polygon mirror type thing, and the example of a trial production of the micro mirror which used the silicon substrate with the latest semiconductor process technology etc. is reported, and a galvanomirror type thing can expect miniaturization, lightweight-izing, and low-cost-ization further.
[0004] The conventional example of such a galvanomirror type optical deflector is shown in drawing 14 - drawing 17 , and drawing 18 , respectively.
[0005] Drawing 14 is the decomposition perspective diagram of the optical deflector of the 1st conventional example, and drawing 15 is the outline side elevation of this optical deflector. In drawing 14 and drawing 15 , the set-up sections 51 and 52 of a right-and-left couple are formed in the base 50, and the oscillating object 53 is arranged on the set-up section 51 of this couple, and 52. The oscillating object 53 consists of supporters 56 and 56 of the couple which connects the reflective mirror section 55 and the outer frame section 54 in the position on the shaft which passes along the abbreviation center of gravity of the outer frame section 54, the reflective mirror section 55 arranged at opening 54a of this outer frame section 54, and this reflective mirror section 55 in one. A part for the right-and-left both ends of the outer frame section 54 is being fixed on the set-up section 51 of a couple, and 52, and the supporters 56 and 56 of a couple are equipped with the function of the torsional-couple spring for vibrating this reflective mirror section 55 while they support the reflective mirror section 55 to the outer frame section 54.
[0006] Moreover, on the base 50, the fixed electrodes 57 and 58 of a right-and-left couple are arranged, and the fixed electrodes 57 and 58 of this couple are arranged in the position which counters the right-and-left both ends of the reflective mirror section 55. The reflective mirror section 55 is constituted as an electrode of the other party of the fixed electrodes 57 and 58 of this couple, and between each fixed electrodes 57 and 58 and the reflective mirror section 55, it is constituted so that voltage can be alternatively impressed through each circuit changing switches SW1 and SW2. In addition, since it connects through the outer frame section 54 and the supporters 56 and 56 of a couple, the reflective mirror section 55 should just impress the voltage impression to the reflective mirror section 55 to the outer frame section 54.
[0007] In the above-mentioned composition, when voltage is impressed between one fixed electrode 57 and the reflective mirror section 55, the left-hand side of the reflective mirror section 55 is attracted by electrostatic force, and the reflective mirror section 55 rotates the supporters 56 and 56 of a couple counterclockwise as a center-of-oscillation shaft CL (shown in drawing 15). again When voltage is impressed between the fixed electrode 58 of another side, and the reflective mirror section 55, the reflective mirror section 55 is attracted by electrostatic force, and the right-hand side of the

reflective mirror section 55 rotates the supporters 56 and 56 of a couple clockwise as a center-of-oscillation shaft CL (shown in drawing 15). Therefore, on-off control of the circuit changing switches SW1 and SW2 is carried out by turns, and the reflective mirror section 55 rocks right and left by impressing voltage to the fixed electrodes 57 and 58 of a couple by turns. Angle of reflection is changed by rocking of the reflective mirror section 55, and the optical deflection of the light irradiated by this reflective mirror section 55 is carried out by this.

[0008] Drawing 18 is the decomposition perspective diagram of the optical deflector of the 2nd conventional example. drawing 18 -- setting -- a base 50 top -- the auxiliary base -- a member 60 is fixed -- having -- this auxiliary base -- the reflective mirror section 55 is arranged in opening 60a of a member 60 the both sides on the shaft which passes along the abbreviation center of gravity of this reflective mirror section 55, and the outside auxiliary base -- between members 60 is connected with the supporters 56 and 56 of a couple The reflective mirror section 55 is constituted free [rocking] focusing on the supporters 56 and 56 of this couple. Moreover, the ctenidium section 61 is constituted by both the heels of the reflective mirror section 55, it is the position of the auxiliary base section 60 which counters each of this ctenidium section 61, and fixed electrodes 57 and 58 are being fixed to the low position from this, respectively. The ctenidium section 62 which gears in the aforementioned ctenidium section 61 is constituted at each reflective mirror section 55 side of the fixed electrodes 57 and 58 of this couple.

[0009] In the above-mentioned composition, when voltage is impressed between one fixed electrode 57 and the reflective mirror section 55, the left-hand side of the reflective mirror section 55 is attracted by electrostatic force, the reflective mirror section 55 sets a center-of-oscillation shaft as the supporters 56 and 56 of a couple, and it rotates counterclockwise. again When voltage is impressed between the fixed electrode 58 of another side, and the reflective mirror section 55, the right-hand side of the reflective mirror section 55 is attracted by electrostatic force, and the reflective mirror section 55 rotates clockwise by setting a center-of-oscillation shaft as the supporters 56 and 56 of a couple. Therefore, the reflective mirror section 55 rocks right and left like the aforementioned 1st conventional example by impressing voltage to the fixed electrodes 57 and 58 of a couple by turns.

[0010]

[Problem(s) to be Solved by the Invention] the [however, / the above 1st and] -- there was a problem which is described below in the 2 conventional example

[0011] That is, in the 1st conventional example, in order to make the reflective mirror section 55 rock at high speed, the one where the weight of the reflective mirror section 55 is lighter is desirable. Here, if thickness t of the reflective mirror section 55 is made thin for lightweight-izing as drawing 16 shows, un-arranging [of a light reflex side bending] will arise, and a problem will appear in rigidity.

[0012] Moreover, in order to enlarge the deflection angle (deflection angle) of the reflective mirror section 55, as shown in drawing 17 , it is necessary to set up greatly the gap interval of the reflective mirror section 55 and fixed electrodes 57 and 58. However, since electrostatic force is in inverse proportion to the square of a gap, it needs very big voltage for obtaining required driving force.

[0013] On the other hand, in the aforementioned 2nd conventional example, unlike the 1st conventional example, if the height of the ctenidium sections 61 and 62 is set up greatly, a large deflection angle can be taken, and if the number of ctenidiums is made [many], big driving force will be obtained by the low battery. However, in order to form the ctenidium section 61 in both the heels of the reflective mirror section 55, it is not avoided that the reflective mirror section 55 is enlarged. If the reflective mirror section 55 is enlarged, since the resonance frequency of the reflective mirror section 55 will fall, it cannot be made to rock at high speed. In order to take a large deflection angle especially, or in order to obtain big driving force by the low battery, the height of the ctenidium sections 61 and 62 is set up greatly, or it becomes increase in quantity of the weight of the reflective mirror section 55 to make [many] the number of ctenidiums, and the fall of the further resonance frequency is caused.

[0014] Then, this invention is made that said technical problem should be solved, and aims at offering the display using the optical deflector and this which are high speed also under low drive power, and a problem does not produce in the rigidity of the reflective mirror section, either, while being able to rock by the extensive deflection angle.

[0015]

[Means for Solving the Problem] The reflective mirror section to which invention of a claim 1 has a light reflex side on a front face, and the supporter of the couple which supports this reflective mirror

section free [rocking] to the base, In the optical deflector to which it has the fixed electrode of the couple arranged at the reflective mirror section side of the aforementioned base, voltage is impressed between each of this fixed electrode and the aforementioned reflective mirror section, and the aforementioned reflective mirror section rocks the supporter of the aforementioned couple as a center-of-oscillation shaft by electrostatic force The mirror side ctenidium section which consists of the slot prolonged in the direction which intersects perpendicularly with the aforementioned center-of-oscillation shaft, and a height is formed in the rear face of the aforementioned reflective mirror section. to the aforementioned reflective mirror section side of each aforementioned fixed electrode It is the optical deflector characterized by forming the electrode side ctenidium section which changes from the slot and height which can be geared to the aforementioned mirror side ctenidium section.
[0016] The reflective mirror section to which invention of a claim 2 has a light reflex side on a front face, and the supporter of the couple which supports this reflective mirror section free [rocking] to the base, It has the fixed electrode of the couple arranged at the reflective mirror section side of the aforementioned base. The mirror side ctenidium section which consists of the slot prolonged in the direction which intersects perpendicularly with the aforementioned center-of-oscillation shaft, and a height is formed in the rear face of the aforementioned reflective mirror section. to the aforementioned reflective mirror section side of each aforementioned fixed electrode The electrode side ctenidium section which changes from the slot and height which can be geared to the aforementioned mirror side ctenidium section is formed. The optical deflector to which voltage is impressed between each aforementioned fixed electrode and the aforementioned reflective mirror section, and the aforementioned reflective mirror section rocks the supporter of the aforementioned couple as a center-of-oscillation shaft by electrostatic force is prepared. It is the display characterized by irradiating a laser beam at the aforementioned reflective mirror section of this optical deflector, changing the direction of the reflected light of this irradiated laser beam by rocking of the aforementioned reflective mirror section, and acquiring a projection picture.
[0017] Invention of a claim 3 is display characterized by projecting the optical information which wrote in the reflected light from the aforementioned reflective mirror section by irradiating at an optical address type space optical modulator, and was written in this optical address type space optical modulator in display given in the aforementioned claim 2.
[0018]
[Embodiments of the Invention] Hereafter, the operation gestalt of this invention is explained based on a drawing.
[0019] Drawing 1 - drawing 4 show the 1st operation gestalt of this invention, and, for the decomposition perspective diagram of optical-deflector 1A, and drawing 1 (B), the outline side elevation of optical-deflector 1A and drawing 2 are [drawing 1 (A) / the outline side elevation of optical-deflector 1A and drawing 4 of the perspective diagram of optical-deflector 1A and drawing 3] the perspective diagrams by the side of the rear face of the reflective mirror section 7.
[0020] In drawing 1 - drawing 4 , the base 2 of optical-deflector 1A has the shape of a flat rectangle, and the set-up section 3 projects in all the periphery edges of this base 2 in one, it is formed in them, and the oscillating object 5 is arranged on this set-up section 3.
[0021] This oscillating object 5 consists of supporters 8 and 8 of the couple which connects the reflective mirror section 7 and the outer frame section 6 in the position on the shaft which passes along the abbreviation center of gravity of the rectangle-like outer frame section 6, the reflective mirror section 7 arranged in opening 6a of this outer frame section 6, and this reflective mirror section 7 in one. And the outer frame section 6 is being fixed on the set-up section 3, and the reflective mirror section 7 is constituted in the supporters 8 and 8 of a couple free [rocking] as a center-of-oscillation shaft CL (shown in drawing 1 and drawing 3). In the front face of the reflective mirror section 7, film attachment of the light reflex film is carried out, and light reflex side 7a is formed.
[0022] Moreover, as shown in drawing 4 in detail, the mirror side ctenidium section 9 which consists of slot 9a prolonged in the direction which intersects perpendicularly with the aforementioned center-of-oscillation shaft CL, and height 9b is formed in the rear face of the reflective mirror section 7 in one. The fixed electrodes 10 and 11 of a right-and-left couple are arranged in the position on the base 2 which counters the mirror side ctenidium section 9 of this reflective mirror section 7, and the electrode side ctenidium section 12 which changes from slot 12a and height 12b also to the upper surface side of the fixed electrodes 10 and 11 of this couple is formed in one. And the mirror side

ctenidium section 9 and the electrode side ctenidium section 12 are arranged so that the heights 9b and 12b of another side may gear with one slots 9a and 12a to the physical relationship which counters mutually, i.e., each other. Between each fixed electrodes 10 and 11 and the reflective mirror section 7, it is constituted so that voltage can be alternatively impressed through each circuit changing switches SW1 and SW2, on-off control of each circuit changing switches SW1 and SW2 is carried out by turns, and it is constituted so that voltage may be impressed to the fixed electrodes 11 and 12 of a couple by turns.

[0023] Moreover, the thickness is formed thinly, and the aforementioned reflective mirror section 7 is highly formed so that an engagement stroke with Slots 9a and 12a and Heights 9b and 12b can specifically obtain a latus deflection angle in the height of the mirror side ctenidium section 9 and the electrode side ctenidium 12. That is, the reflective mirror section 7 is lightweight as a whole, and resonance frequency is constituted highly.

[0024] As shown in drawing 1 (B), when voltage is impressed between one fixed electrode 10 and the reflective mirror section 7 in the above-mentioned composition, the left-hand side of the reflective mirror section 7 is attracted by electrostatic force, the reflective mirror section 7 sets the center-of-oscillation shaft CL as the supporter 8 of a couple, and it rotates counterclockwise. again As shown in drawing 3 , when voltage is impressed between the fixed electrode 11 of another side, and the reflective mirror section 7 While the suction force of one fixed electrode 10 is canceled and the supporter 8 of the twisted couple tends to return the reflective mirror section 7 to the original position according to the elastic return force The right-hand side of the reflective mirror section 7 is attracted by electrostatic force, and the reflective mirror section 7 rotates clockwise by setting the center-of-oscillation shaft CL as the supporter 8 of a couple. Therefore, if on-off control of the circuit changing switches SW1 and SW2 is carried out by turns, the reflective mirror section 7 will rock right and left by impressing voltage to the fixed electrodes 10 and 11 of a couple by turns. Angle of reflection is changed by rocking of the reflective mirror section 7, and the optical deflection of the light irradiated by this reflective mirror section 7 is carried out by this. In addition, the voltage impression to the reflective mirror section 7 is impressed to the outer frame section 6 which has connected this reflective mirror section 7.

[0025] Here, the driving force of the reflective mirror section 7 is obtained by the electrostatic force generated between the mirror side ctenidium section 9 and the electrode side ctenidium section 12, and since both gap intervals are narrow irrespective of a rocking position and fixed, it can obtain big driving force on low voltage. In addition, the grade of the size of driving force is explained in full detail below.

[0026] And the height of the mirror side ctenidium section 9 and the electrode side ctenidium section 12 is set as height required to obtain a desired deflection angle, and the reflective mirror section 7 can be made to rock by the deflection angle big [it is lightweight, and] since resonance frequency is constituted highly which is high speed also under low voltage. If the reflective mirror section 7 is especially vibrated by resonance frequency, since the reflective mirror section 7 will vibrate at the maximum serious grade, a big turning effort can be obtained with low power.

[0027] Moreover, since height 9b of the mirror side ctenidium section 9 functions also as a rib which raises intensity, even if the reflective mirror section 7 forms thickness thinly, a problem does not produce it in rigidity, like light reflex side 7a bends. Since the reflective mirror section 7 forms the mirror side ctenidium section 9 in the rear-face side and the whole front face of the reflective mirror section 7 can be constituted as light reflex side 7a, lightweight-ization is attained also from this point that what is necessary is just to set it as the minimum size required as light reflex side 7a.

[0028] Next, the size of the electrostatic force the case of the ctenidium electrode of this invention and in the case of the flat electrode of the 1st conventional example is compared. The electrostatic force to which the electrostatic force F generated when voltage V is generally impressed between a fixed electrode and the reflective mirror section 7 which is moving part will commit a gap interval in one ctenidium side in the case of a ctenidium electrode like drawing 5 (A) if width of face of W and an electrode is set [the dielectric constant between g and a gap] to L for the depth of epsilon and an electrode is set to F=epsilon V2W/2g. In the case of an parallel flat electrode like drawing 5 (B), it is set to F=epsilon V2WL/2g2.

[0029] In the case of an parallel flat electrode, although electrostatic force becomes large by the square of a GYAPU interval, if it is going to take the large deflection angle of the reflective mirror section 7, it is necessary to enlarge this gap interval. Therefore, it becomes difficult to obtain big

electrostatic force. On the other hand, since the reflective mirror section 7 moves in parallel to a gap in the case of a ctenidium electrode, the gap interval is fixed. Therefore, since a gap interval is made as small as possible, it can obtain big electrostatic force. furthermore -- since two or more several n of a ctenidium can be boiled and can be carried out -- electrostatic force -- an upper formula -- further -- it becomes 2n time

[0030] Next, a concrete numeric value is substituted and the case of both sides is compared. If the size of the reflective mirror section 7 is used as 2mm angle as shown in drawing 6 , it will be set to W= 1mm and L= 2mm in an upper formula. Moreover, if a deflection angle is made into **10 degrees, the electrostatic force f which will commit every [50 piece (40 micrometer pitch)] and the gap interval g to the ctenidium of a lot if the number of ctenidiums is set to 2 micrometers at each electrode in the case of a ctenidium electrode will be set to f=epsilon V2x1/2x(2x10-4) =2.5x102xepsilonV2. Since there is the 2nd page of a field which electrostatic force commits in the ctenidium of a lot and there are 50 ctenidiums, the electrostatic force F as the whole is set to F=2x50f=2.5x105xepsilonV2.

[0031] Since in the case of an parallel flat electrode the endmost part of the reflective mirror section 7 displaces 176 micrometers when a deflection angle is **10 degrees, it serves as the gap interval g. Therefore, electrostatic force F is set to F=epsilon V2x1x2/2x(176x10-4)2=3.2x103xepsilonV2.

[0032] As mentioned above, when it is made a ctenidium electrode, about 80 times as many electrostatic force as this will be obtained on the same voltage. Furthermore, in the case of a ctenidium electrode, it is possible also for increasing the number of ctenidiums by the manufacture method, or narrowing a gap interval, and it can also obtain bigger electrostatic force.

[0033] Drawing 7 is a perspective diagram by the side of the rear face of optical-deflector 1B which shows the 2nd operation gestalt of this invention. It is in this 2nd operation gestalt, and the same composition part as the aforementioned 1st operation gestalt gives the same sign to a drawing, the explanation is omitted, and only different composition is explained.

[0034] That is, as shown in drawing 7 , the rib 20 which connects between adjoining height 9b is formed in the position on the center-of-oscillation shaft CL which is the rear-face side of the reflective mirror section 7, and passes along the supporters 8 and 8 of a couple, without preparing slot 9a. This part serves as more rigid improvement, in order that a rib 20 may strengthen intensity of the reflective mirror section 7 further, while the electrostatic force of the same size is obtained compared with the aforementioned 1st operation gestalt, since it is a part unrelated to an operation of electrostatic force.

[0035] Drawing 8 and drawing 9 show the 3rd operation gestalt of this invention, and drawing 8 and drawing 9 are the outline side elevations of optical-deflector 1C, respectively. In drawing 8 and drawing 9 , since other composition is the same, it is in this 3rd operation gestalt, and only the composition of the mirror side ctenidium section 9 and the electrode side ctenidium section 12 is different as compared with the aforementioned 1st operation gestalt, and only the composition of the mirror side ctenidium section 9 and the electrode side ctenidium section 12 is explained, and other composition gives the same sign to a drawing, and omits the explanation.

[0036] That is, with this 3rd operation gestalt, the length of the rocking direction (direction which intersects perpendicularly with the center-of-oscillation shaft CL) of the mirror side ctenidium section 9 and the electrode side ctenidium section 12 is formed shorter than the length of the rocking direction of the reflective mirror section 7. Since an angle until the free end (outside edge) of the reflective mirror section 7 collides with fixed electrodes 10 and 11 or the base 2 by doing in this way is made greatly, a deflection angle can be enlarged. As for drawing 9 , it turns out that the state where voltage was impressed is shown and the rocking angle is large compared with the case of drawing 3 of the 1st operation gestalt between one fixed electrode 10 and the reflective mirror section 7.

[0037] Drawing 10 and drawing 11 show the 4th operation gestalt of this invention, and drawing 10 and drawing 11 are the outline side elevations of optical-deflector 1D. In drawing 10 and drawing 11 , since other composition is the same, it is in this 4th operation gestalt, and only the composition of the mirror side ctenidium section 9 and the electrode side ctenidium section 12 is different as compared with the aforementioned 1st operation gestalt, and only the composition of the mirror side ctenidium section 9 and the electrode side ctenidium section 12 is explained, and other composition gives the same sign to a drawing, and omits the explanation.

[0038] That is, with this 4th operation gestalt, the height of the mirror side ctenidium section 9 and the electrode side ctenidium section 12 is formed so that it may become low as it keeps away from

the center-of-oscillation shaft CL. Since an angle until the free end (outside edge) of the reflective mirror section 7 collides with fixed electrodes 10 and 11 is greatly made even if it sets up narrowly the interval of the reflective mirror section 7 and fixed electrodes 10 and 11 by doing in this way, a deflection angle can be enlarged. As for drawing 11 , it turns out that the state where voltage was impressed is shown and the rocking angle is large compared with the case of drawing 3 of the 1st operation gestalt between one fixed electrode 10 and the reflective mirror section 7.

[0039] As mentioned above, it becomes [if the vacuum lock of the interior of each optical deflectors 1A-1D is carried out using methods, such as anode plate junction, can lose the influence of air resistance to rocking of the reflective mirror section 7, and / with a rockable] high speed more and is desirable, although according to the above 1st - the 4th operation gestalt it is high speed also under a low battery and an extensive deflection angle can be rocked.

[0040] Drawing 12 is the outline block diagram of display which used each above-mentioned optical deflectors 1A-1D. In drawing 12 , the laser beam discharged from the laser light source 30 is irradiated by the optical-deflection child 31 for horizontal scannings. The reflective mirror section is rocked synchronizing with a horizontal frequency, and, as for the optical-deflection child 31 for horizontal scannings, the reflected light is horizontally scanned by this rocking. The laser beam reflected here is irradiated by the optical-deflection child 32 for vertical scannings. The reflective mirror section is rocked synchronizing with perpendicular frequency, and, as for this optical-deflection child 32 for vertical scannings, the reflected light is perpendicularly scanned by this rocking. The laser beam reflected here is irradiated by the screen 33.

[0041] As each above-mentioned optical deflectors 1A-1D were used as an optical-deflection child 31 for horizontal scannings and being described above, it is high speed, and since it can rock by the extensive deflection angle, it can be made to be able to synchronize with a dozens of kHz scanning frequency, and can be made to rock. Of course, you may use each above-mentioned optical deflectors 1A-1D also for the optical-deflection child 32 for vertical scannings.

[0042] Drawing 13 is the outline block diagram of other display which used each above-mentioned optical deflectors 1A-1D. In drawing 13 , the laser beam discharged from the laser light source 30 is irradiated by the optical-deflection child 31 for horizontal scannings. The reflective mirror section is rocked synchronizing with a horizontal frequency, and, as for the optical-deflection child 31 for horizontal scannings, the reflected light is horizontally scanned by this rocking. The laser beam reflected here is irradiated by the optical-deflection child 32 for vertical scannings. The reflective mirror section is rocked synchronizing with perpendicular frequency, and, as for this optical-deflection child 32 for vertical scannings, the reflected light is perpendicularly scanned by this rocking. The laser beam reflected here is irradiated by the optical address type space modulation element 35 through a focusing lens 34. The optical address type space modulation element 35 writes in this optical information, amplifies lightness, brightness, etc. and displays this on a front-face side by liquid crystal.

[0043] On the other hand, incidence of the light from a lamp 36 is carried out to the Poral RIZESHON beam splitter 40 through an infrared cut filter 37, a lens 38, and the wavelength filter 39, and this reflected light is irradiated by the optical address type space modulation element 35. Incidence of the light which reflected this optical address type space modulation element 35 is again carried out to the Poral RIZESHON beam splitter 40, and the light which penetrated this is irradiated by the screen 33 through a lens 41.

[0044] As each above-mentioned optical deflectors 1A-1D were used as an optical-deflection child 31 for horizontal scannings and being described above, it is high speed, and since it can rock by the extensive deflection angle, it can be made to be able to synchronize with a dozens of kHz scanning frequency, and can be made to rock. Of course, you may use each above-mentioned optical deflectors 1A-1D also for the optical-deflection child 32 for vertical scannings.

[0045] In addition, according to the aforementioned operation gestalt, although display was shown as an example of application of an optical deflector, of course, it is applicable to the scanner of optical instruments, such as an electrophotography formula copying machine, a laser beam printer, and a bar code reader, the optical-deflection equipment of the tracking-control equipment of an optical disk, etc.

[0046]

[Effect of the Invention] In the optical deflector to rock according [as explained above, according to invention of a claim 1, the reflective mirror section sets a center-of-oscillation shaft as the supporter

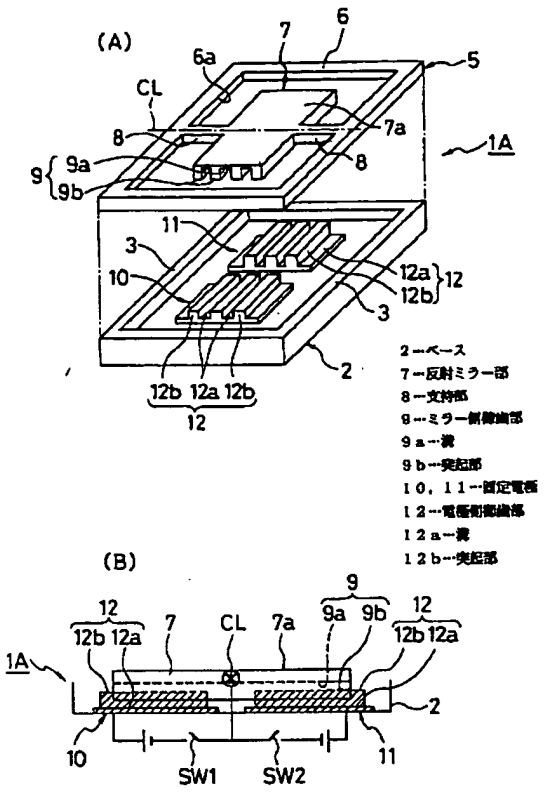
of a couple, and] to electrostatic force The mirror side ctenidium section which consists of the slot prolonged in the direction which intersects perpendicularly with the aforementioned center-of-oscillation shaft, and a height is formed in the rear face of the reflective mirror section. to the aforementioned reflective mirror section side of the fixed electrode of a couple Since the electrode side ctenidium section which changes from the slot and height which can be geared to the aforementioned mirror side ctenidium section was formed Even if it sets the height of the mirror side ctenidium section and the electrode side ctenidium section as height required to obtain a desired deflection angle, the gap interval of the mirror side ctenidium section and the electrode side ctenidium section does not change. Moreover, a thing to form the size of the reflective mirror section in the minimum size required for a **** slant face, since the mirror side ctenidium section was formed in the rear-face side of the reflective mirror section, Since rigidity is maintainable even if it forms the thickness of the reflective mirror section thinly, since the height of the mirror side ctenidium section functions as an on-the-strength rib, it is lightweight in the reflective mirror section and resonance frequency can be constituted in a high thing, also under low voltage and at high speed And while being able to make it rock by the big deflection angle, a problem does not arise in the rigidity of the reflective mirror section, either.

[0047] According to invention of a claim 2, the reflective mirror section is constituted free [rocking] to the base focusing on the supporter of a couple. The fixed electrode of a couple is arranged to the reflective mirror section side of the base, and the mirror side ctenidium section is formed in the rear face of the aforementioned reflective mirror section. to the aforementioned reflective mirror section side of each aforementioned fixed electrode The optical deflector to which the electrode side ctenidium section which gears in the aforementioned mirror side ctenidium section is formed, voltage is impressed between each aforementioned fixed electrode and the aforementioned reflective mirror section, and the aforementioned reflective mirror section rocks the supporter of the aforementioned couple as a center-of-oscillation shaft by electrostatic force is prepared. Since it constituted so that a laser beam might be irradiated at the aforementioned reflective mirror section of this optical deflector, the direction of the reflected light of this irradiated laser beam might be changed by rocking of the aforementioned reflective mirror section and a projection picture might be acquired, the high picture of a scanning frequency can be displayed.

[0048] Since the reflected light from the aforementioned reflective mirror section projected the optical information which wrote in by irradiating at an optical address type space optical modulator, and was written in this optical address type space optical modulator in display given in the aforementioned claim 2 according to invention of a claim 3, the high picture of a scanning frequency can be displayed using an optical address type space modulation element.

[Translation done.]

Drawing selection [Representative drawing]



[Translation done.]

[Translation done.]

PRIOR ART

[Description of the Prior Art] The optical polariscope is used for the optical-deflection equipment of the scanner of optical instruments, such as an electrophotography formula copying machine, a laser beam printer, and a bar code reader, and the tracking-control equipment of an optical disk, and the display which scans a laser beam and projects an image.

[0003] As an optical polariscope which generally performs an optical deflection mechanically, although there are a rotating polygon (polygon mirror), a stirred-up type reflecting mirror (galvanomirror) of a riot, etc., a mechanism can be miniaturized compared with a polygon mirror type thing, and the example of a trial production of the micro mirror which used the silicon substrate with the latest semiconductor process technology etc. is reported, and a galvanomirror type thing can expect miniaturization, lightweight-izing, and low-cost-ization further.

[0004] The conventional example of such a galvanomirror type optical deflector is shown in drawing 14 - drawing 17 , and drawing 18 , respectively.

[0005] Drawing 14 is the decomposition perspective diagram of the optical deflector of the 1st conventional example, and drawing 15 is the outline side elevation of this optical deflector. In drawing 14 and drawing 15 , the set-up sections 51 and 52 of a right-and-left couple are formed in the base 50, and the oscillating object 53 is arranged on the set-up section 51 of this couple, and 52. The oscillating object 53 consists of supporters 56 and 56 of the couple which connects the reflective mirror section 55 and the outer frame section 54 in the position on the shaft which passes along the abbreviation center of gravity of the outer frame section 54, the reflective mirror section 55 arranged at opening 54a of this outer frame section 54, and this reflective mirror section 55 in one. A part for the right-and-left both ends of the outer frame section 54 is being fixed on the set-up section 51 of a couple, and 52, and the supporters 56 and 56 of a couple are equipped with the function of the torsional-couple spring for vibrating this reflective mirror section 55 while they support the reflective mirror section 55 to the outer frame section 54.

[0006] Moreover, on the base 50, the fixed electrodes 57 and 58 of a right-and-left couple are arranged, and the fixed electrodes 57 and 58 of this couple are arranged in the position which counters the right-and-left both ends of the reflective mirror section 55. The reflective mirror section 55 is constituted as an electrode of the other party of the fixed electrodes 57 and 58 of this couple, and between each fixed electrodes 57 and 58 and the reflective mirror section 55, it is constituted so that voltage can be alternatively impressed through each circuit changing switches SW1 and SW2. In addition, since it connects through the outer frame section 54 and the supporters 56 and 56 of a couple, the reflective mirror section 55 should just impress the voltage impression to the reflective mirror section 55 to the outer frame section 54.

[0007] In the above-mentioned composition, when voltage is impressed between one fixed electrode 57 and the reflective mirror section 55, the left-hand side of the reflective mirror section 55 is attracted by electrostatic force, and the reflective mirror section 55 rotates the supporters 56 and 56 of a couple counterclockwise as a center-of-oscillation shaft CL (shown in drawing 15). again When voltage is impressed between the fixed electrode 58 of another side, and the reflective mirror section 55, the reflective mirror section 55 is attracted by electrostatic force, and the right-hand side of the reflective mirror section 55 rotates the supporters 56 and 56 of a couple clockwise as a center-of-oscillation shaft CL (shown in drawing 15). Therefore, on-off control of the circuit changing switches SW1 and SW2 is carried out by turns, and the reflective mirror section 55 rocks right and left by impressing voltage to the fixed electrodes 57 and 58 of a couple by turns. Angle of reflection is changed by rocking of the reflective mirror section 55, and the optical deflection of the light irradiated by this reflective mirror section 55 is carried out by this.

[0008] Drawing 18 is the decomposition perspective diagram of the optical deflector of the 2nd conventional example. drawing 18 -- setting -- a base 50 top -- the auxiliary base -- a member 60 is fixed -- having -- this auxiliary base -- the reflective mirror section 55 is arranged in opening 60a of a member 60 the both sides on the shaft which passes along the abbreviation center of gravity of this reflective mirror section 55, and the outside auxiliary base -- between members 60 is connected with the supporters 56 and 56 of a couple The reflective mirror section 55 is constituted free [rocking] focusing on the supporters 56 and 56 of this couple. Moreover, the ctenidium section 61 is constituted by both the heels of the reflective mirror section 55, it is the position of the auxiliary base section 60 which counters each of this ctenidium section 61, and fixed electrodes 57 and 58 are being fixed to the position lower than this, respectively. The ctenidium section 62 which gears in the aforementioned ctenidium section 61 is constituted at each reflective mirror section 55 side of the fixed electrodes 57 and 58 of this couple.

[0009] In the above-mentioned composition, when voltage is impressed between one fixed electrode 57 and the reflective mirror section 55, the left-hand side of the reflective mirror section 55 is attracted by electrostatic force, the reflective mirror section 55 sets a center-of-oscillation shaft as the supporters 56 and 56 of a couple, and it rotates counterclockwise. again When voltage is impressed between the fixed electrode 58 of another side, and the reflective mirror section 55, the right-hand side of the reflective mirror section 55 is attracted by electrostatic force, and the reflective mirror section 55 rotates clockwise by setting a center-of-oscillation shaft as the supporters 56 and 56 of a couple. Therefore, the reflective mirror section 55 rocks right and left like the aforementioned 1st conventional example by impressing voltage to the fixed electrodes 57 and 58 of a couple by turns.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] In the optical deflector to rock according [as explained above, in invention of a claim 1, the reflective mirror section sets a center-of-oscillation shaft as the supporter of a couple, and] to electrostatic force The mirror side ctenidium section which consists of the slot prolonged in the direction which intersects perpendicularly with the aforementioned center-of-oscillation shaft, and a height was formed in the rear face of the reflective mirror section, and the electrode side ctenidium section which changes from the slot and height which can be geared to the aforementioned mirror side ctenidium section was formed in the aforementioned reflective mirror section side of the fixed electrode of a couple. Therefore, even if it sets the height of the mirror side ctenidium section and the electrode side ctenidium section as height required to obtain a desired deflection angle, the gap interval of the mirror side ctenidium section and the electrode side ctenidium section does not change. Moreover, a thing to form the size of the reflective mirror section in the minimum size required for a **** slant face, since the mirror side ctenidium section was formed in the rear-face side of the reflective mirror section, Since rigidity is maintainable even if it forms the thickness of the reflective mirror section thinly, since the height of the mirror side ctenidium section functions as an on-the-strength rib, it is lightweight in the reflective mirror section and resonance frequency can be constituted in a high thing, also under low voltage and at high speed And while being able to make it rock by the big deflection angle, a problem does not arise in the rigidity of the reflective mirror section, either.

[0047] The reflective mirror section is constituted from invention of a claim 2 free [rocking] to the base focusing on the supporter of a couple. The fixed electrode of a couple is arranged to the reflective mirror section side of the base, and the mirror side ctenidium section is formed in the rear face of the aforementioned reflective mirror section. to the aforementioned reflective mirror section side of each aforementioned fixed electrode The optical deflector to which the electrode side ctenidium section which gears in the aforementioned mirror side ctenidium section is formed, voltage is impressed between each aforementioned fixed electrode and the aforementioned reflective mirror section, and the aforementioned reflective mirror section rocks the supporter of the aforementioned couple as a center-of-oscillation shaft by electrostatic force is prepared. The laser beam was irradiated at the aforementioned reflective mirror section of this optical deflector, and it constituted so that the direction of the reflected light of this irradiated laser beam might be changed by rocking of the aforementioned reflective mirror section and a projection picture might be acquired. Therefore, the high picture of a scanning frequency can be displayed.

[0048] Since the reflected light from the aforementioned reflective mirror section projected the optical information which wrote in by irradiating at an optical address type space optical modulator, and was written in this optical address type space optical modulator in display given in the aforementioned claim 2 according to invention of a claim 3, the high picture of a scanning frequency can be displayed using an optical address type space modulation element.

[Translation done.]

[Translation done.]

[Translation done.]

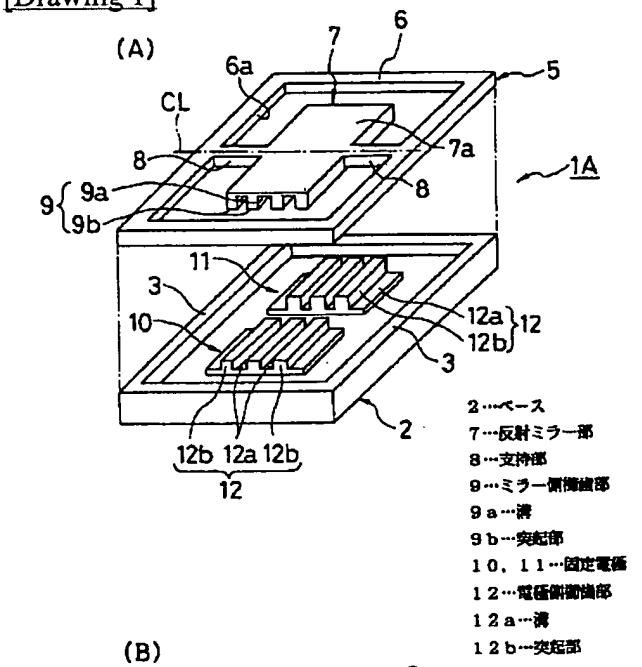
[Translation done.]

* NOTICES *

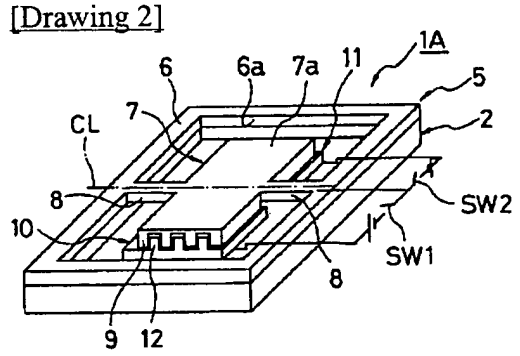
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

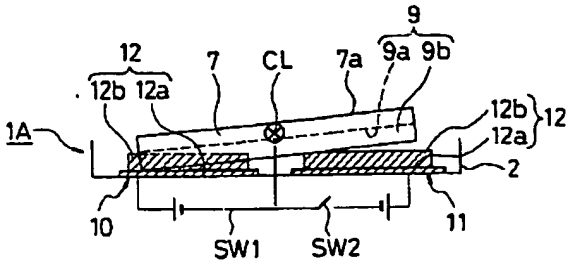
[Drawing 1]



[Drawing 2]



[Drawing 3]



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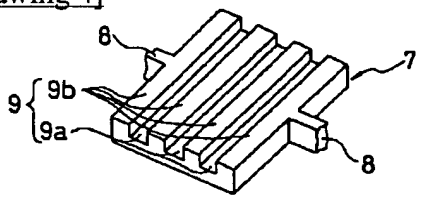
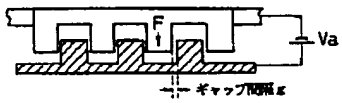


[Drawing 5]

(A)



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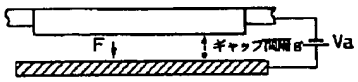

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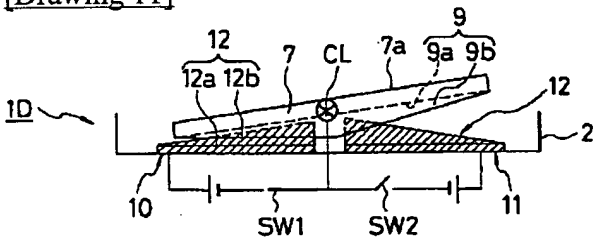
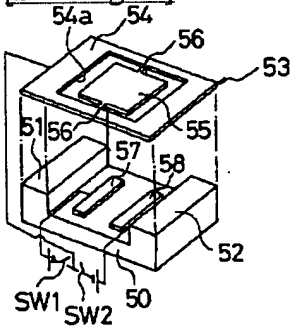
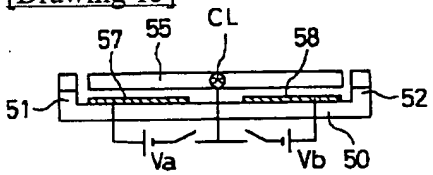


[Drawing 14]



[Drawing 15]



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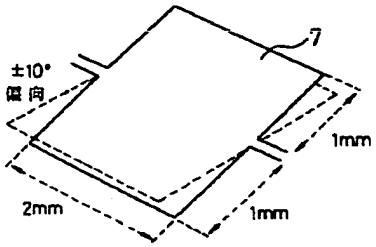

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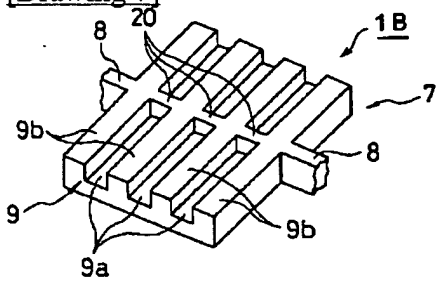
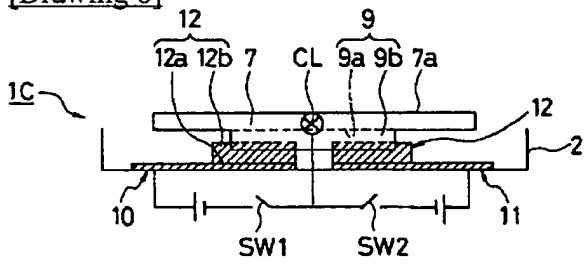


[Drawing 8]



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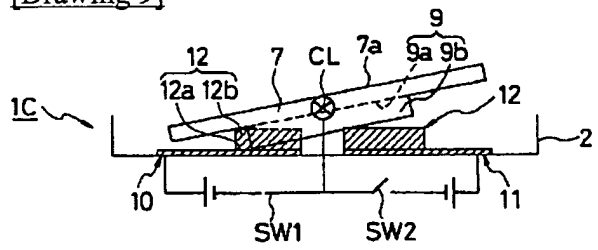
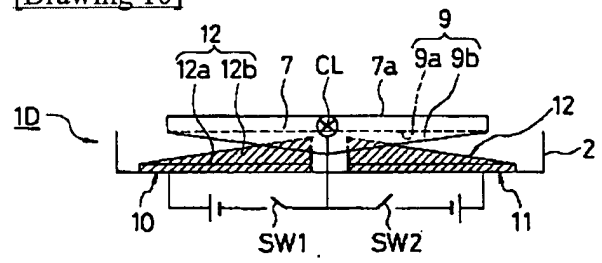
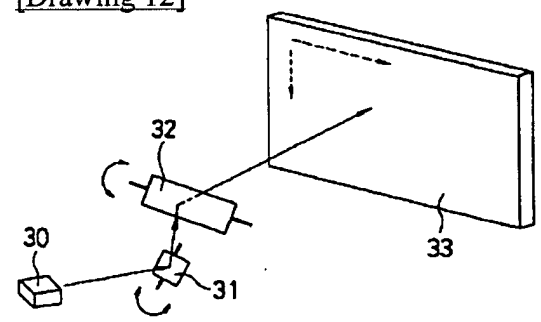


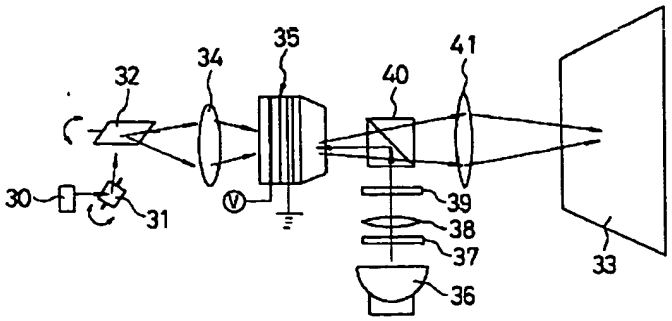
[Drawing 10]



[Drawing 12]



[Drawing 13]



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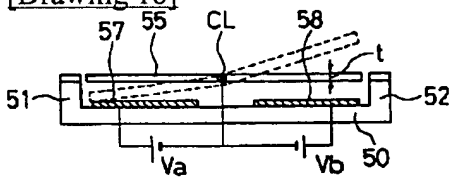
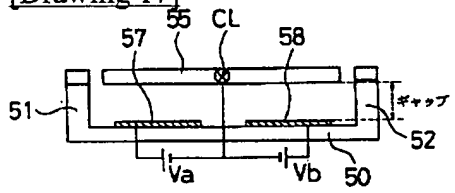
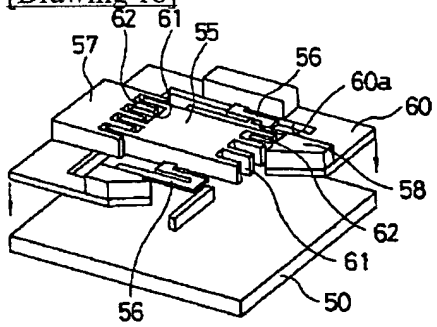


[Drawing 17]



[Drawing 18]



[Translation done.]

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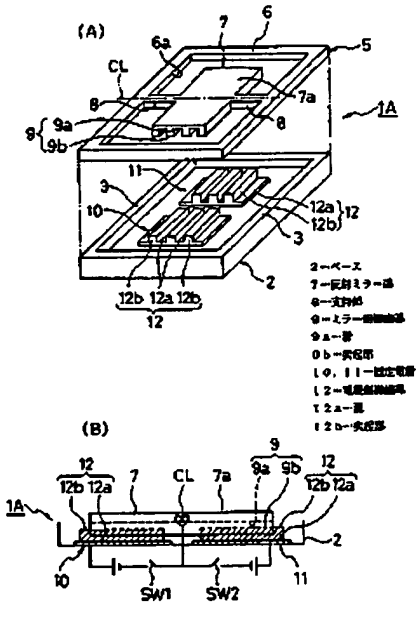
最終頁に続く

(54)【発明の名称】　光偏向器及びこれを用いた表示装置

(57)【要約】
【課題】　低い駆動電力の下でも高速で、且つ、広偏向角で揺動することができると共に、反射ミラー部の剛性にも問題が生じない。
【解決手段】　反射ミラー部７を一対の支持部８，８を介してベース２に揺動自在に構成し、ベース２に一対の固定電極１０，１１を配置し、この各固定電極１０，１１と反射ミラー部７との間に電圧を印加して静電力で反射ミラー部７が一対の支持部８，８を揺動中心軸ＣＬとして揺動する光偏向器１において、反射ミラー部７の裏面には揺動中心軸ＣＬに直交する方向に延びる溝９ａと突起部９ｂとから成るミラー側櫛歯部９を形成し、各固定電極１０，１１の反射ミラー部７側には、ミラー側櫛歯部９に噛み合い可能な溝１２ａと突起部１２ｂとから成る電極側櫛歯部１２を形成した。



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【特許請求の範囲】

【請求項１】　表面に光反射面を有する反射ミラー部と．この反射ミラー部をベースに対して揺動自在に支持する一対の支持部と、前記ベースの反射ミラー部側に配置された一対の固定電極とを有し、この各固定電極と前記反射ミラー部との間に電圧を印加して静電力で前記反射ミラー部が前記一対の支持部を揺動中心軸として揺動する光偏向器において、

前記反射ミラー部の裏面には前記揺動中心軸に直交する方向に延びる溝と突起部とから成るミラー側櫛歯部を形成し．前記各固定電極の前記反射ミラー部側には．前記ミラー側櫛歯部に噛み合い可能な溝と突起部とから成る電極側櫛歯部を形成したことを特徴とする光偏向器。

【請求項２】　表面に光反射面を有する反射ミラー部と．この反射ミラー部をベースに対して揺動自在に支持する一対の支持部と、前記ベースの反射ミラー部側に配置された一対の固定電極とを有し、前記反射ミラー部の裏面には前記揺動中心軸に直交する方向に延びる溝と突起部とから成るミラー側櫛歯部を形成し、前記各固定電極の前記反射ミラー部側には、前記ミラー側櫛歯部に噛み合い可能な溝と突起部とから成る電極側櫛歯部を形成し．前記各固定電極と前記反射ミラー部との間に電圧を印加して静電力で前記反射ミラー部が前記一対の支持部を揺動中心軸として揺動する光偏向器を設け、

この光偏向器の前記反射ミラー部にレーザ光を照射し、この照射されたレーザ光の反射光の方向を前記反射ミラー部の揺動によって変化させて投影画像を得ることを特徴とする表示装置。

【請求項３】　前記請求項２に記載の表示装置において．

前記反射ミラー部からの反射光は、光アドレス型空間光変調素子に照射することによって書き込み、この光アドレス型空間光変調素子に書き込んだ光情報を投影したことを特徴とする表示装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は．レーザビーム等の光を反射させて光偏向を行う光偏向器．及び、この光偏向器を用いた表示装置に関する。

【０００２】

【従来の技術】電子写真式複写機、レーザビームプリンタ．バーコードリーダ等の光学機器の走査装置や．光ディスクのトラッキング制御装置の光偏向装置や．レーザ光をスキャニングして映像を投影する表示装置などには光偏光器が使用されている。

【０００３】一般に、機械的に光偏向を行う光偏光器としては、回転多面鏡（ポリゴンミラー）、駆動型反射鏡（ガルバノミラー）等があるが、ガルバノミラー型のものはポリゴンミラー型のものに比べて機構が小型化でき．又、最近の半導体プロセス技術ではシリコン基板を

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用いたマイクロミラーの試作例なども報告されており、さらに小型化．軽量化、低コスト化が期待できる。

【０００４】このようなガルバノミラー型の光偏向器の従来例が図１４～図１７と図１８とにそれぞれ示されている。

【０００５】図１４は第１従来例の光偏向器の分解斜視図．図１５はこの光偏向器の概略側面図である。図１４及び図１５において、ベース５０には左右一対の立設部５１．５２が設けられ、この一対の立設部５１．５２上には振動体５３が配置されている。振動体５３は外枠部５４と、この外枠部５４の開口部５４ａに配置された反射ミラー部５５と、この反射ミラー部５５の略重心を通る軸上の位置で反射ミラー部５５と外枠部５４とを連結する一対の支持部５６，５６とから一体的に構成されている。外枠部５４の左右両端部分が一対の立設部５１，５２上に固定されており．一対の支持部５６，５６は外枠部５４に対して反射ミラー部５５を支持すると共に、この反射ミラー部５５を振動させるための捩りバネの機能を備えている。

【０００６】又．ベース５０上には左右一対の固定電極５７．５８が配置され、この一対の固定電極５７．５８は反射ミラー部５５の左右両端部に対向する位置に配置されている。この一対の固定電極５７．５８の相手側の電極として反射ミラー部５５が構成され、各固定電極５７．５８と反射ミラー部５５との間には各切替スイッチＳＷ１，ＳＷ２を介して選択的に電圧を印加できるように構成されている。尚、反射ミラー部５５は外枠部５４と一対の支持部５６，５６を介して接続されているため．反射ミラー部５５への電圧印加は外枠部５４に印加すれば良い。

【０００７】上記構成において、一方の固定電極５７と反射ミラー部５５との間に電圧が印加されたときには反射ミラー部５５の左側が静電力により吸引されて反射ミラー部５５が一対の支持部５６，５６を揺動中心軸ＣＬ（図１５に示す）として反時計方向に回転し、又．他方の固定電極５８と反射ミラー部５５との間に電圧が印加されたときには反射ミラー部５５が静電力により吸引されて反射ミラー部５５の右側が一対の支持部５６．５６を揺動中心軸ＣＬ（図１５に示す）として時計方向に回転する。従って．切替スイッチＳＷ１．ＳＷ２を交互にオン・オフ制御し、一対の固定電極５７，５８に交互に電圧を印加することによって反射ミラー部５５が左右に揺動するものである。この反射ミラー部５５に照射された光は、反射ミラー部５５の揺動によって反射角が変更され．これによって光偏向される。

【０００８】図１８は第２従来例の光偏向器の分解斜視図である。図１８において．ベース５０上には補助ベース部材６０が固定され、この補助ベース部材６０の開口部６０ａ内に反射ミラー部５５が配置されている。この反射ミラー部５５の略重心を通る軸上の両側と外補助ベ

ース部材６０との間が一対の支持部５６，５６で連結されている。反射ミラー部５５はこの一対の支持部５６，５６を中心として揺動自在に構成されている。又，反射ミラー部５５の両外端部には櫛歯部６１が構成されており，この各櫛歯部６１に対向する補助ベース部６０の位置で，且つ，これより低い位置には固定電極５７，５８がそれぞれ固定されている。この一対の固定電極５７，５８の各反射ミラー部５５側には前記櫛歯部６１に噛み合う櫛歯部６２が構成されている。

【０００９】上記構成において，一方の固定電極５７と反射ミラー部５５との間に電圧が印加されたときには反射ミラー部５５の左側が静電力により吸引されて反射ミラー部５５が一対の支持部５６，５６を揺動中心軸として反時計方向に回転し，又，他方の固定電極５８と反射ミラー部５５との間に電圧が印加されたときには反射ミラー部５５の右側が静電力により吸引されて反射ミラー部５５が一対の支持部５６，５６を揺動中心軸として時計方向に回転する。従って，前記第１従来例と同様に，一対の固定電極５７，５８に交互に電圧を印加することによって反射ミラー部５５が左右に揺動するものである。

【００１０】

【発明が解決しようとする課題】しかしながら，前記第１及び第２従来例においては，以下に述べるような問題があった。

【００１１】即ち，第１従来例において，反射ミラー部５５を高速で揺動させるためには，反射ミラー部５５の重量がより軽い方が望ましい。ここで，図１６で示すように，軽量化のために反射ミラー部５５の厚みｔを薄くすると，光反射面が撓んでしまう等の不都合が生じ剛性に問題がでる。

【００１２】又，反射ミラー部５５の偏向角（振れ角）を大きくするには，図１７に示すように，反射ミラー部５５と固定電極５７，５８とのギャップ間隔を大きく設定する必要がある。しかし，静電力は，ギャップの２乗に反比例するので，必要な駆動力を得るには非常に大きな電圧を必要とする。

【００１３】一方，前記第２従来例においては，第１従来例と異なり，櫛歯部６１，６２の高さを大きく設定すれば偏向角を大きく取ることができ，櫛歯の数を多くすれば低電圧で大きな駆動力が得られる。しかしながら，反射ミラー部５５の両外端部に櫛歯部６１を設けるために，反射ミラー部５５が大型化するのは避けられない。反射ミラー部５５が大型化すると，反射ミラー部５５の共振周波数が低下するため，高速で揺動させることができない。特に，偏向角を大きく取るため，又は，低電圧で大きな駆動力を得るため，櫛歯部６１，６２の高さを大きく設定したり，櫛歯数を多くすることは反射ミラー部５５の重量の増量となり，さらなる共振周波数の低下を招く。

【００１４】そこで，本発明は，前記した課題を解決すべくなされたものであり，低い駆動電力の下でも高速で，且つ，広偏向角で揺動することができると共に，反射ミラー部の剛性にも問題が生じない光偏向器及びこれを用いた表示装置を提供することを目的とする。

【００１５】

【課題を解決するための手段】請求項１の発明は，表面に光反射面を有する反射ミラー部と，この反射ミラー部をベースに対して揺動自在に支持する一対の支持部と，前記ベースの反射ミラー部側に配置された一対の固定電極とを有し，この各固定電極と前記反射ミラー部との間に電圧を印加して静電力で前記反射ミラー部が前記一対の支持部を揺動中心軸として揺動する光偏向器において，前記反射ミラー部の裏面には前記揺動中心軸に直交する方向に延びる溝と突起部とから成るミラー側櫛歯部を形成し，前記各固定電極の前記反射ミラー部側には，前記ミラー側櫛歯部に噛み合い可能な溝と突起部とから成る電極側櫛歯部を形成したことを特徴とする光偏向器である。

【００１６】請求項２の発明は，表面に光反射面を有する反射ミラー部と，この反射ミラー部をベースに対して揺動自在に支持する一対の支持部と，前記ベースの反射ミラー部側に配置された一対の固定電極とを有し，前記反射ミラー部の裏面には前記揺動中心軸に直交する方向に延びる溝と突起部とから成るミラー側櫛歯部を形成し，前記各固定電極の前記反射ミラー部側には，前記ミラー側櫛歯部に噛み合い可能な溝と突起部とから成る電極側櫛歯部を形成し，前記各固定電極と前記反射ミラー部との間に電圧を印加して静電力で前記反射ミラー部が前記一対の支持部を揺動中心軸として揺動する光偏向器を設け，この光偏向器の前記反射ミラー部にレーザ光を照射し，この照射されたレーザ光の反射光の方向を前記反射ミラー部の揺動によって変化させて投影画像を得ることを特徴とする表示装置である。

【００１７】請求項３の発明は，前記請求項２に記載の表示装置において，前記反射ミラー部からの反射光は，光アドレス型空間光変調素子に照射することによって書き込み，この光アドレス型空間光変調素子に書き込んだ光情報を投影したことを特徴とする表示装置である。

【００１８】

【発明の実施の形態】以下，本発明の実施形態を図面に基づいて説明する。

【００１９】図１～図４は本発明の第１実施形態を示し，図１（Ａ）は光偏向器１Ａの分解斜視図，図１（Ｂ）は光偏向器１Ａの概略側面図，図２は光偏向器１Ａの斜視図，図３は光偏向器１Ａの概略側面図，図４は反射ミラー部７の裏面側の斜視図である。

【００２０】図１～図４において，光偏向器１Ａのベース２は偏平長方形状を有し，このベース２の全外周端には立設部３が一体的に突出形成されており，この立設部

３上に振動体５が配置されている。

【００２１】この振動体５は、方形状の外枠部６と、この外枠部６の開口部６ａ内に配置された反射ミラー部７と、この反射ミラー部７の略重心を通る軸上の位置で反射ミラー部７と外枠部６とを連結する一対の支持部８，８とから一体的に構成されている。そして、外枠部６が立設部３上に固定されており、反射ミラー部７は一対の支持部８，８を揺動中心軸ＣＬ（図１，図３に示す）として揺動自在に構成されている。反射ミラー部７の表面には光反射膜が膜付けされて光反射面７ａが形成されている。

【００２２】また、図４に詳しく示すように、反射ミラー部７の裏面には前記揺動中心軸ＣＬに直交する方向に延びる溝９ａと突起部９ｂとから成るミラー側櫛歯部９が一体的に形成されている。この反射ミラー部７のミラー側櫛歯部９に対向するベース２上の位置には左右一対の固定電極１０，１１が配置され、この一対の固定電極１０，１１の上面側にも溝１２ａと突起部１２ｂとから成る電極側櫛歯部１２が一体的に形成されている。そして、ミラー側櫛歯部９と電極側櫛歯部１２とは、一方の溝９ａ，１２ａと他方の突起部９ｂ，１２ｂとが互いに対向する位置関係、つまり、互いに噛み合うように配置されている。各固定電極１０，１１と反射ミラー部７との間には各切替スイッチＳＷ１，ＳＷ２を介して選択的に電圧を印加できるよう構成されており、各切替スイッチＳＷ１，ＳＷ２を交互にオン・オフ制御し、一対の固定電極１１，１２に交互に電圧を印加するように構成されている。

【００２３】また、前記反射ミラー部７はその厚みが薄く形成され、且つ、ミラー側櫛歯部９及び電極側櫛歯１２の高さ、具体的には溝９ａ，１２ａと突起部９ｂ，１２ｂとの噛み合いストロークは広い偏向角を得られるように高く形成されている。つまり、反射ミラー部７は全体として軽量で、共振周波数が高く構成されている。

【００２４】上記構成において、図１（Ｂ）に示すように、一方の固定電極１０と反射ミラー部７との間に電圧が印加されたときには反射ミラー部７の左側が静電力により吸引されて反射ミラー部７が一対の支持部８を揺動中心軸ＣＬとして反時計方向に回転し、又、図３に示すように、他方の固定電極１１と反射ミラー部７との間に電圧が印加されたときには、一方の固定電極１０の吸引力が解除され、捩じられた一対の支持部８が弾性復帰力により反射ミラー部７を元の位置に戻そうとすると共に、反射ミラー部７の右側が静電力により吸引されて反射ミラー部７が一対の支持部８を揺動中心軸ＣＬとして時計方向に回転する。従って、切替スイッチＳＷ１，ＳＷ２を交互にオン・オフ制御されると、一対の固定電極１０，１１に交互に電圧を印加することによって反射ミラー部７が左右に揺動するものである。この反射ミラー部７に照射された光は、反射ミラー部７の揺動によって反射角が変更され、これによって光偏向される。尚、反射ミラー部７への電圧印加は、この反射ミラー部７を接続している外枠部６に印加している。

【００２５】ここで、反射ミラー部７の駆動力は、ミラー側櫛歯部９と電極側櫛歯部１２との間に発生する静電力によって得られ、且つ、双方のギャップ間隔が揺動位置にかかわらず狭く一定であるため、低い電圧で大きな駆動力を得ることができる。尚、駆動力の大きさの程度は下記に詳述する。

【００２６】そして、ミラー側櫛歯部９と電極側櫛歯部１２との高さは、所望の偏向角を得るのに必要な高さに設定され、且つ、反射ミラー部７は軽量で共振周波数が高く構成されているため、低い電圧の下でも高速で、且つ、大きな偏向角で揺動させることができる。特に、反射ミラー部７を共振周波数で振動させると、反射ミラー部７が最大変位で振動するため、低電力で大きな回転力を得ることができる。

【００２７】又、反射ミラー部７はミラー側櫛歯部９の突起部９ｂが強度を高めるリブとしても機能するため、厚みを薄く形成しても光反射面７ａが撓む等の剛性に問題が生じない。反射ミラー部７は、その裏面側にミラー側櫛歯部９を設け、反射ミラー部７の表面全体を光反射面７ａとして構成できるため、光反射面７ａとして必要最少限の大きさに設定すれば良く、この点からも軽量化が図られる。

【００２８】次に、本発明の櫛歯電極の場合と第１従来例の平面電極の場合とにおける静電力の大きさを比較する。一般的に、固定電極と可動部である反射ミラー部７との間に電圧Ｖを印加した場合に発生する静電力Ｆは、ギャップ間隔をｇ、ギャップ間の誘電率をε、電極の奥行きをＷ、電極の幅をＬとすると、図５（Ａ）のような櫛歯電極の場合には、１つの櫛歯面に働く静電力は、$F=\varepsilon V^2W/2g$となる。図５（Ｂ）のような平行平面電極の場合には、$F=\varepsilon V^2WL/2g^2$となる。

【００２９】平行平面電極の場合、静電力はギャップ間隔の２乗で大きくなるが、反射ミラー部７の偏向角を大きく取ろうとすると、このギャップ間隔を大きくする必要がある。従って、大きな静電力を得ることが困難になる。これに対し、櫛歯電極の場合、反射ミラー部７はギャップに対して平行に移動するので、ギャップ間隔は一定である。従って、ギャップ間隔は可能な限り小さくできるため、大きな静電力を得ることができる。さらに、櫛歯の数ｎを複数にすることができるので、静電力は上式のさらに２ｎ倍になる。

【００３０】次に、双方の場合を具体的な数値を代入して比較する。図６に示すように、反射ミラー部７の大きさを２ｍｍ角とすると、上式においてＷ＝１ｍｍ、Ｌ＝２ｍｍとなる。又、偏向角を±１０度とすると、櫛歯電極の場合、櫛歯の数をそれぞれの電極に５０個（４０μｍピッチ）ずつ、ギャップ間隔ｇを２μｍとすると、一

組の櫛歯に働く静電力fは、$f=\varepsilon V^2\times 1/2\times(2\times10^{-4})=2.5\times10^{4}\times\varepsilon V^2$となる。一組の櫛歯には静電力の働く面が２面あり、又、櫛歯が５０個あるので、全体としての静電力Fは、$F=2\times50f=2.5\times10^{6}\times\varepsilon V^2$となる。

【００３１】平行平面電極の場合、偏向角が±１０度のとき反射ミラー部７の最端部が１７６μｍ変位するので、それがギャップ間隔ｇとなる。従って、静電力Fは、$F=\varepsilon V^2\times1\times2/2\times(176\times10^{-4})^2=3.2\times10^{3}\times\varepsilon V^2$となる。

【００３２】以上より、櫛歯電極にした場合、同じ電圧で約８０倍の静電力が得られることになる。さらに、櫛歯電極の場合は、製造方法により櫛歯の数を増やしたり、ギャップ間隔を狭くしたりすることも可能であり、より大きな静電力を得ることも可能である。

【００３３】図７は本発明の第２実施形態を示す光偏向器１Ｂの裏面側の斜視図である。この第２実施形態にあって前記第１実施形態と同一構成箇所は図面に同一符号を付してその説明を省略し、異なる構成のみを説明する。

【００３４】即ち、図７に示すように、反射ミラー部７の裏面側であって、且つ、一対の支持部８，８を通る揺動中心軸ＣＬ上の位置には溝９ａを設けずに、隣接する突起部９ｂ間を連結するリブ２０が形成されている。この箇所は静電力の作用には無関係の箇所であるため、前記第１実施形態と比べて同様な大きさの静電力が得られると共に、リブ２０が反射ミラー部７の強度をさらに強くするため、より剛性の向上となるものである。

【００３５】図８及び図９は本発明の第３実施形態を示し、図８及び図９はそれぞれ光偏向器１Ｃの概略側面図である。図８及び図９において、この第３実施形態にあって前記第１実施形態と比較してミラー側櫛歯部９と電極側櫛歯部１２との構成のみが相違し、他の構成は同一であるため、ミラー側櫛歯部９と電極側櫛歯部１２との構成のみを説明し、その他の構成は図面に同一符号を付してその説明を省略する。

【００３６】即ち、この第３実施形態では、ミラー側櫛歯部９と電極側櫛歯部１２との揺動方向（揺動中心軸ＣＬに直交する方向）の長さが反射ミラー部７の揺動方向の長さよりも短く形成されている。このようにすることによって、反射ミラー部７の自由端（外側端部）が固定電極１０，１１又はベース２に衝突するまでの角度が大きくできるため、偏向角を大きくすることができる。図９は一方の固定電極１０と反射ミラー部７間に電圧を印加した状態を示し、第１実施形態の図３の場合に比べて揺動角が大きくなっていることが分かる。

【００３７】図１０及び図１１は本発明の第４実施形態を示し、図１０及び図１１は光偏向器１Ｄの概略側面図である。図１０及び図１１において、この第４実施形態にあって前記第１実施形態と比較してミラー側櫛歯部９と電極側櫛歯部１２との構成のみが相違し、他の構成は同一であるため、ミラー側櫛歯部９と電極側櫛歯部１２との構成のみを説明し、その他の構成は図面に同一符号を付してその説明を省略する。

【００３８】即ち、この第４実施形態では、ミラー側櫛歯部９と電極側櫛歯部１２との高さが、揺動中心軸ＣＬから遠ざかるに従って低くなるように形成されている。このようにすることによって、反射ミラー部７と固定電極１０，１１との間隔を狭く設定しても反射ミラー部７の自由端（外側端部）が固定電極１０，１１に衝突するまでの角度が大きくできるため、偏向角を大きくすることができる。図１１は一方の固定電極１０と反射ミラー部７間に電圧を印加した状態を示し、第１実施形態の図３の場合に比べて揺動角が大きくなっていることが分かる。

【００３９】以上、前記第１～第４実施形態によれば、低電圧の下でも高速で、且つ、広偏向角の揺動を行うことができるが、各光偏向器１Ａ～１Ｄの内部を陽極接合等の方法を用いて真空封止すれば反射ミラー部７の揺動に対し空気抵抗の影響をなくすことができ、より高速に揺動可能となり好ましい。

【００４０】図１２は、上記各光偏向器１Ａ～１Ｄを用いた表示装置の概略構成図である。図１２において、レーザ光源３０より発射されたレーザ光は、水平走査用光偏向子３１に照射される。水平走査用光偏向子３１は水平周波数に同期して反射ミラー部が揺動され、この揺動によって反射光が水平方向に走査される。ここで反射されたレーザ光は垂直走査用光偏向子３２に照射される。この垂直走査用光偏向子３２は垂直周波数に同期して反射ミラー部が揺動され、この揺動によって反射光が垂直方向に走査される。ここで反射されたレーザ光がスクリーン３３に照射される。

【００４１】水平走査用光偏向子３１として上記各光偏向器１Ａ～１Ｄを用いられており、上記したように高速で、且つ、広偏向角で揺動できるため、数十ｋＨｚの走査周波数に同期させて揺動させることができる。もちろん、垂直走査用光偏向子３２にも上記各光偏向器１Ａ～１Ｄを用いても良い。

【００４２】図１３は、上記各光偏向器１Ａ～１Ｄを用いた他の表示装置の概略構成図である。図１３において、レーザ光源３０より発射されたレーザ光は、水平走査用光偏向子３１に照射される。水平走査用光偏向子３１は水平周波数に同期して反射ミラー部が揺動され、この揺動によって反射光が水平方向に走査される。ここで反射されたレーザ光は垂直走査用光偏向子３２に照射される。この垂直走査用光偏向子３２は垂直周波数に同期して反射ミラー部が揺動され、この揺動によって反射光が垂直方向に走査される。ここで反射されたレーザ光が集束レンズ３４を通って光アドレス型空間変調素子３５に照射される。光アドレス型空間変調素子３５はこの光

情報を書き込み．これを表面側に明度．輝度等を増幅して液晶で表示する。

【００４３】一方、ランプ３６からの光は赤外線カットフィルタ３７．レンズ３８．波長フィルタ３９を通ってポラリゼーション・ビームスプリッタ４０に入射され、この反射光が光アドレス型空間変調素子３５に照射される。この光アドレス型空間変調素子３５を反射した光は再びポラリゼーション・ビームスプリッタ４０に入射され．ここを透過した光がレンズ４１を介してスクリーン３３に照射される。

【００４４】水平走査用光偏向子３１として上記各光偏向器１Ａ～１Ｄを用いられており、上記したように高速で．且つ、広偏向角で揺動できるため．数十ｋＨｚの走査周波数に同期させて揺動させることができる。もちろん．垂直走査用光偏向子３２にも上記各光偏向器１Ａ～１Ｄを用いても良い。

【００４５】尚．前記実施形態によれば、光偏向器の適用例として表示装置を示したが、電子写真式複写機、レーザビームプリンタ、バーコードリーダ等の光学機器の走査装置や、光ディスクのトラッキング制御装置の光偏向装置等にも適用できることはもちろんである。

【００４６】

【発明の効果】以上説明したように．請求項１の発明によれば、反射ミラー部が一対の支持部を揺動中心軸として静電力による揺動する光偏向器において、反射ミラー部の裏面には前記揺動中心軸に直交する方向に延びる溝と突起部とから成るミラー側櫛歯部を形成し、一対の固定電極の前記反射ミラー部側には、前記ミラー側櫛歯部に噛み合い可能な溝と突起部とから成る電極側櫛歯部を形成したので．ミラー側櫛歯部と電極側櫛歯部との高さを．所望の偏向角を得るのに必要な高さに設定してもミラー側櫛歯部と電極側櫛歯部とのギャップ間隔が変化せず．又、反射ミラー部の裏面側にミラー側櫛歯部を形成したことから反射ミラー部の大きさを光反斜面に必要な最少限の大きさに形成すればよいこと．及び、ミラー側櫛歯部の突起部が強度リブとして機能することから反射ミラー部の厚みを薄く形成しても剛性を維持できることから反射ミラー部を軽量で共振周波数を高いものに構成できるため、低い電圧の下でも高速で．且つ、大きな偏向角で揺動させることができると共に．反射ミラー部の剛性にも問題が生じない。

【００４７】請求項２の発明によれば．反射ミラー部を一対の支持部を中心にベースに対して揺動自在に構成し．ベースの反射ミラー部側に一対の固定電極を配置し．前記反射ミラー部の裏面にはミラー側櫛歯部を形成し．前記各固定電極の前記反射ミラー部側には．前記ミラー側櫛歯部に噛み合う電極側櫛歯部を形成し．前記各固定電極と前記反射ミラー部との間に電圧を印加して静電力で前記反射ミラー部が前記一対の支持部を揺動中心軸として揺動する光偏向器を設け、この光偏向器の前記反射ミラー部にレーザ光を照射し、この照射されたレーザ光の反射光の方向を前記反射ミラー部の揺動によって変化させて投影画像を得るように構成したので．走査周波数の高い画像を表示できる。

【００４８】請求項３の発明によれば．前記請求項２に記載の表示装置において．前記反射ミラー部からの反射光は．光アドレス型空間光変調素子に照射することによって書き込み．この光アドレス型空間光変調素子に書き込んだ光情報を投影したので、光アドレス型空間変調素子を用いて走査周波数の高い画像を表示できる。

【図面の簡単な説明】

【図１】（Ａ）は本発明の第１実施形態に係る光偏向器の分解斜視図．（Ｂ）は同光偏向器の概略側面図である。

【図２】本発明の第１実施形態に係る光偏向器の斜視図である。

【図３】本発明の第１実施形態に係る光偏向器の概略側面図である。

【図４】本発明の第１実施形態を示す反射ミラー部の裏面側の斜視図である。

【図５】（Ａ）は本発明の櫛歯電極の場合における静電力を説明するための側面図．（Ｂ）は第１従来例の平行平面電極の場合における静電力を説明するための側面図である。

【図６】静電力の具体的大きさを説明するための反射ミラー部の斜視図である。

【図７】本発明の第２実施形態を示す反射ミラー部の裏面側の斜視図である。

【図８】本発明の第３実施形態を示す光偏光器の側面図である。

【図９】本発明の第３実施形態を示す光偏光器の側面図である。

【図１０】本発明の第４実施形態を示す光偏光器の側面図である。

【図１１】本発明の第４実施形態を示す光偏光器の側面図である。

【図１２】光偏向器を用いた表示装置の概略構成図である。

【図１３】光偏向器を用いた他の表示装置の概略構成図である。

【図１４】第１従来例の光偏向器の分解斜視図である。

【図１５】第１従来例の光偏光器の側面図である。

【図１６】第１従来例の光偏光器にあって反射ミラー部の厚みを薄くした場合の側面図である。

【図１７】第１従来例の光偏光器にあって反射ミラー部とベースとのギャップ間隔を広くした場合の側面図である。

【図１８】第２従来例の光偏向器の分解斜視図である。

【符号の説明】

１Ａ～１Ｄ　光偏光器

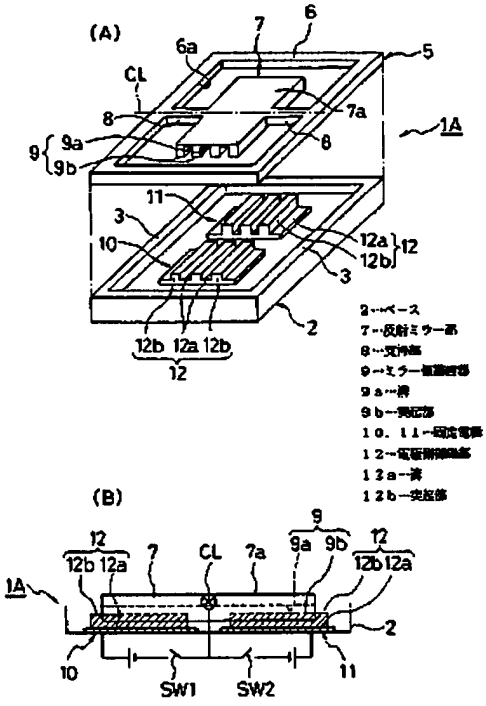
11

2　ベース
7　反射ミラー部
7ａ　光反斜面
8　支持部
9　ミラー側櫛歯部
9ａ　溝

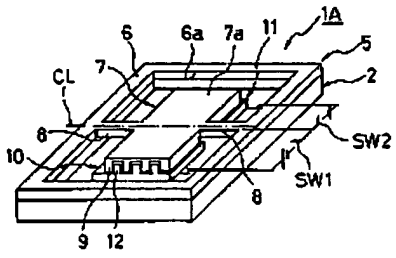
12

＊９ｂ　突起部
１０．１１　固定電極
１２　電極側櫛歯部
１２ａ　溝
１２ｂ　突起部
＊　ＣＬ　揺動中心軸

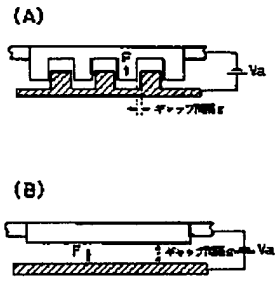
【図１】



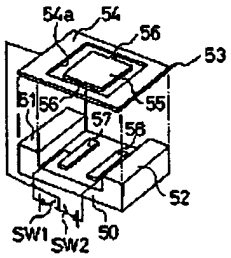
【図２】



【図５】

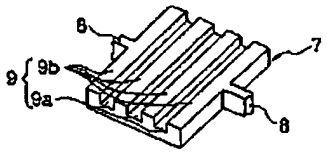


【図１４】

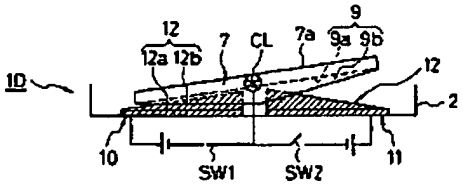


【図３】

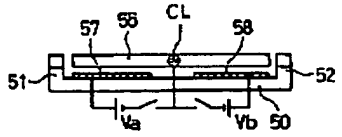
【図４】



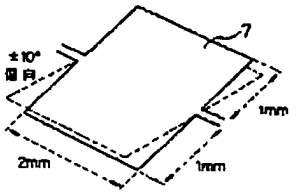
【図１１】



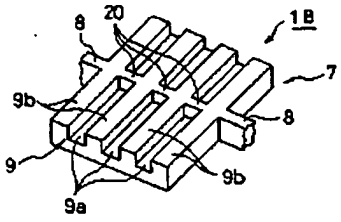
【図１５】



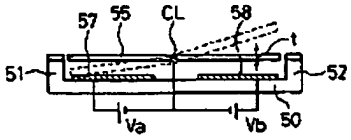
【図6】



【図7】



【図16】



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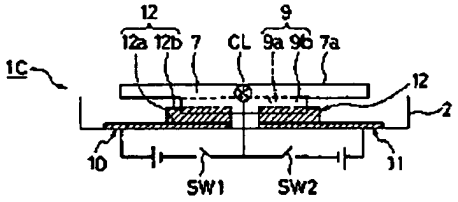
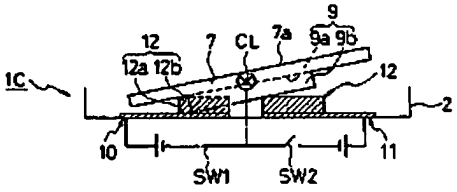
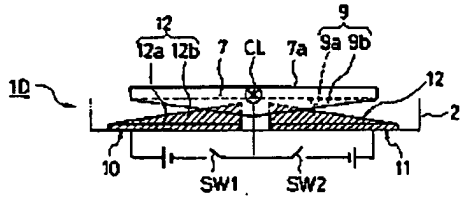


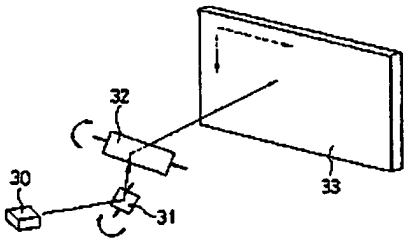
【図9】



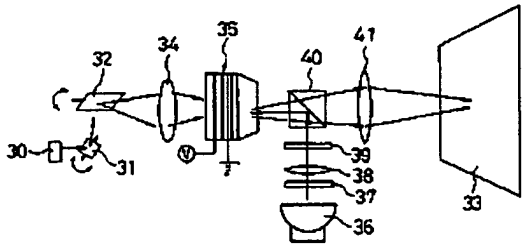
【図10】



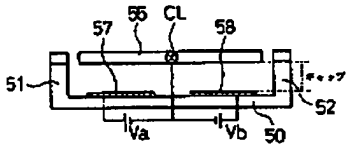
【図12】



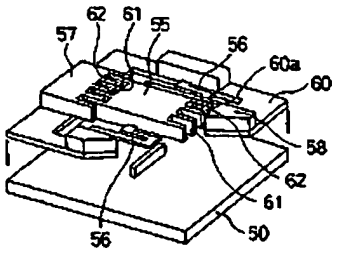
【図13】



【図17】



【図１８】



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